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ArcGIS Final Project:
Tornado Tracks vs Population Shifts within Sedgwick County, KS

INTRODUCTION OF PROBLEM

The most violent of tornados can have wind speeds of 300 mph. Wind speeds of that magnitude can cause extremely heavy and large objects to become airborne, such as cars. Those airborne objects are what create the most damage. Thus the damage caused by a tornado is extremely variable because it is not only dependent upon wind speed, but it is also dependent upon what objects will be in its path. Also, because of this variability, it is hard to quantify

In this project, we wish to see how previous tornados between 1990 to the present day have affected population shift. For this project we will use Sedgwick County, Kansas that has a moderately dense population, and long history of tornado tracks passing through the area. We will track the shift in populations in ten year periods using Census Data collected from the townships that subdivide Sedgwick County. We also chose this county because it has had a history of population increase through the past century. Thus if a population within a township decreases as opposed to increases between the ten years in which the census data was collected and that township is touched by a tornado track within that 10 year period, we can logically conclude that the tornado damage was a factor in the population decrease of that area.

It must also be stated that the damage zone and hazard zone around a tornado track are hard to quantify because the variability of building density/objects that can become airborne and the variability of wind speed of the tornado as it travels.

DATA COLLECTION
-   Kansas GIS data taken from the state of Kansas gis data access and support center http://www.kansasgis.org/catalog/
-   Tornado tracks taken from the NOAA's National Weather Service Storm Prediction Center website: http://www.spc.noaa.gov/gis/svrgis/
-   2000 population data of Sedgwick County, Kansas: http://www.census.gov/prod/cen2000/dp1/2kh20.pdf
-   1990 population data of Sedgwick County, Kansas: http://books.google.com/books?id=Y6ZwY0zBBxoC&pg=PA322&lpg=PA322&dq=attica+township+sedgwick+county+kansas+population+census+1990&source=bl&ots=FYyjWkWSt4&sig=jJolSdKeG-mQH9-R55XtZRU9JoY&hl=en&sa=X&ei=MoCCVN_CKcSegwTUsIDIBg&ved=0CFAQ6AEwCQ#v=onepage&q=attica%20township%20sedgwick%20county%20kansas%20population%20census%201990&f=false

PROCEDURE

The procedures below outline the list of steps involved in converting the data that we have acquired into the type of data we want, so that we can find the answer to our question posed above. The blue highlighted portions of the procedures involve actual steps within ArcMap; the non-highlighted portions provide background information or reasoning for why we are doing the highlighted steps.

1) Make a folder connection within ArcCatalog by clicking the add folder connection button circled in red in Figure 1 below. A window should pop up allowing you to choose your folder. Click the desired folder, and then press 'Ok.'
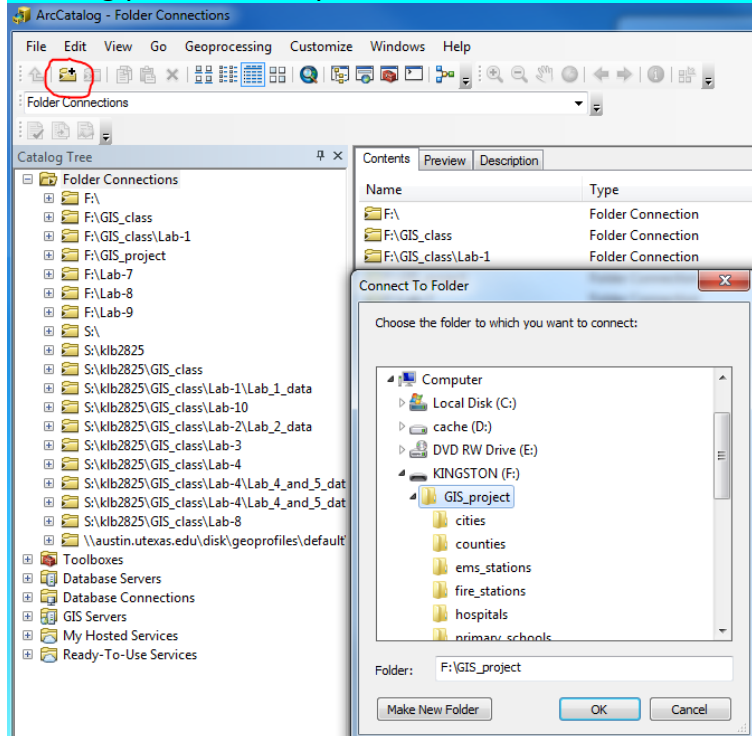

Figure 1. Circled Folder Connection tab in ArcCatalog.

2) Find data and add to connected folder (see data collection section for data sources)

3) Click the 'Add Data' button and search for the desired layers in the connected folder. We're going to add the counties, tornado tracks, and population density shapefiles to our map.
   a. Make sure that the added shapefiles all share the same Coordinate System. We chose the 'USA Contiguous Lambert Conformal Conic' projection.

4) The county we are interested in is Sedgwick County. This means that we have to create a new shape file from the Kansas state counties shapefile, and clip all of our other shape files to be contained within Sedgwick County.
   a. To create a new shapefile for Sedgwick County, first we have to select which files we want to be able to edit in the 'List by Selection' portion of the Table of Contents (see Figure 2). Click everything off, except for the
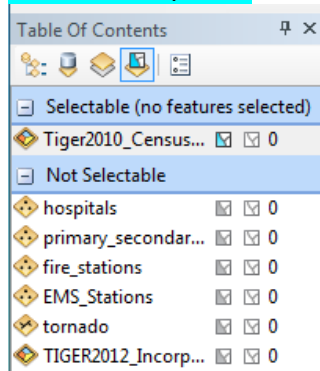
counties shapefile.

Figure 2. 'List by Selection' Tab in the Table of Contents.

b. Next click on the 'editor' tool bar and click 'start editing.' Choose the layer that you want to edit, it this case we will select the counties shapefile. Then press Ok.

   i. **If you encounter an error, stop editing immediately and make sure that all your shapefiles are in the same coordinate system. Then start editing again**
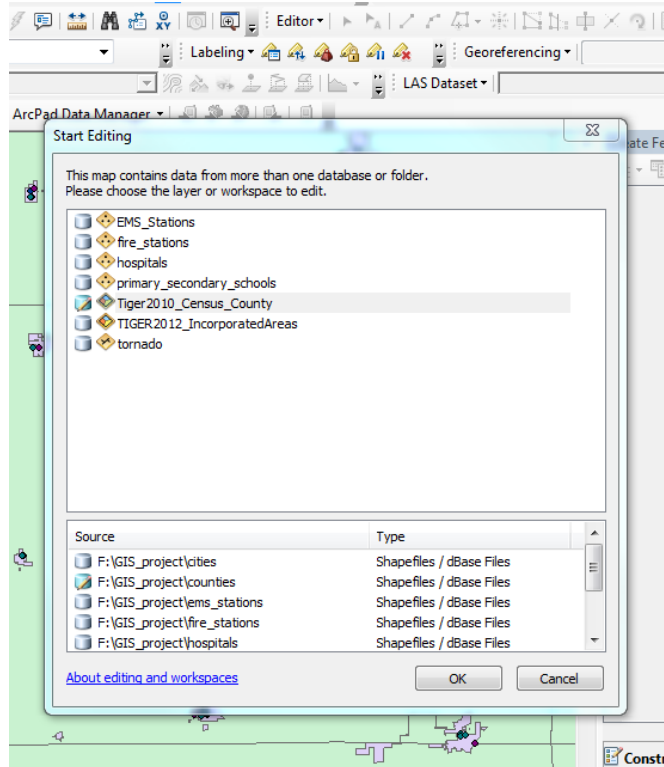

Figure 3. Pop-up window for choosing the layer with which to start editing.

c. Next, click the 'edit tool' and select the Sedgwick county polygon. Then in the TOC (table of contents), right click on the counties shapefile and navigate to the 'Data' bar, and within the 'Data' bar, click 'Export Data.'

i. Select 'Selected Feature' and use the same coordinate system as 'this layer's source data.'

ii. In the 'output feature class' select the folder you wish to save the new file to, and save the file as a shapefile. Then click OK.
**creating the new shapefile this way preserves the information already in the original shapefile that can be seen in the attributes table.
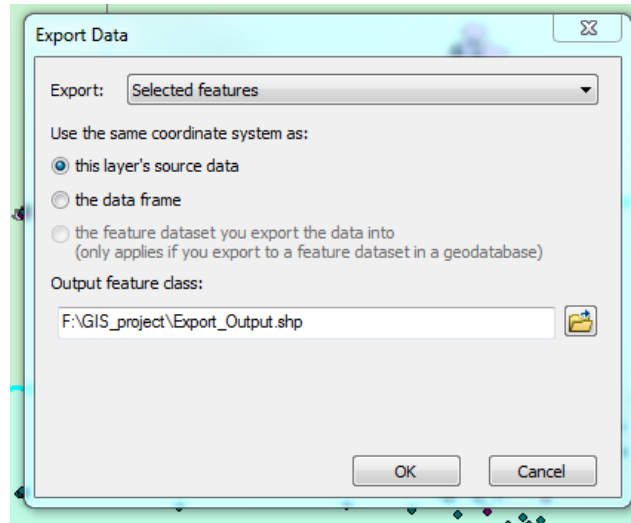
Figure 4. Pop-up window for exporting the selected data as a shapefile.

iii. When the new layer is created, click 'yes' when ArcMap asks whether or not you want to add the exported data to the map as a layer.

d. Now that we have the county shapefile, we can clip the other shapefiles that cover larger areas to just the area we want, Sedgwick County, using ArcToolbox.

i. Open ArcToolbox and within the Analysis Tools, click 'Extract' and then click the 'Clip' tool.

ii. In the 'Input Features' browse the folder for the shapefiles that we want to be down-sized to fit within Sedgwick county, and select a file.

iii. In the 'Clip features' browse the folder and select the newly created Sedgwick county shapefile. This will be the bounding feature.

iv. In the 'Output Feature Class' browse for the folder we wish to place the new file in, and name the new file. Then click 'Ok.' The
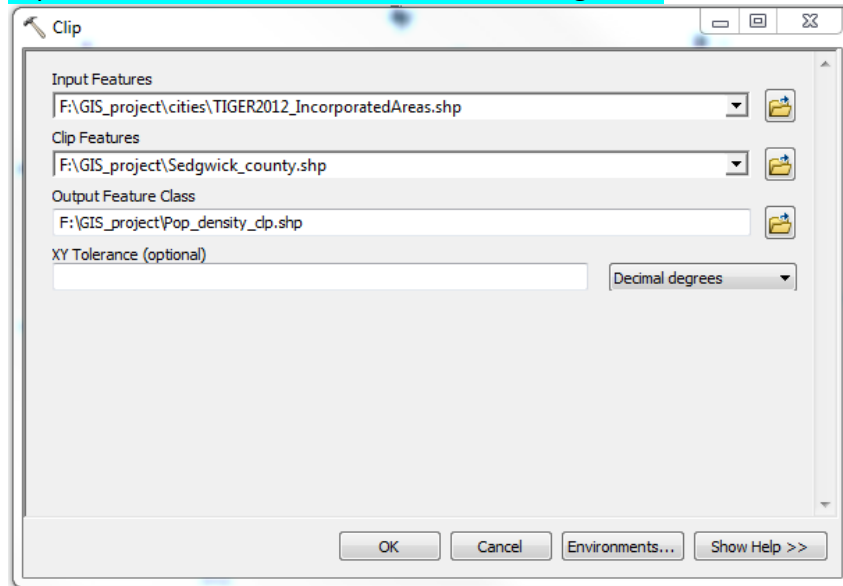
Figure 5. Pop-up box for the Clip tool.

v.   We will essentially clip all the shapefiles so that they fit within Sedgwick County since we downloaded the data for the whole state. Use the same procedure above for all the other files when clipping. When done it should appear something like the picture below in Figure 6.
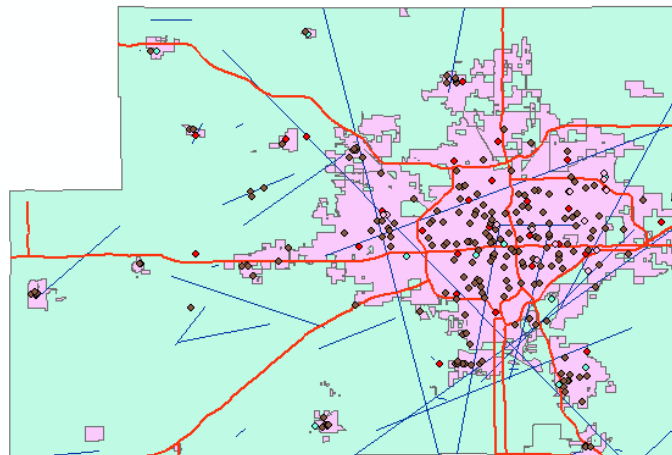

Figure 6. Clipped shapefiles to within Sedgwick County, KS.

5) Now we're going to symbolize various feature within our map to make certain characteristics distinct and to help us analyze problems later on.
    a.   First we're going to categorize the tornado tracks by year using color, and magnitude by line thickness.

6) Next we're going to visually categorize to the population density shapefile so that we can see the distribution of population. The population within the shapefile is from the 2010 census data, so the population is recorded per 'township' of which there are 27 within Sedgwick County. The shapefile we downloaded from the Kansas Data Access & Support Center website is very large since it subdivides the townships so there are over 13,000 entries instead of just 27. Thus we need to aggregate the polygons within the same townships based on their FIPS (each township has a code called a 'Federal Information Processing Standard' (FIPS)). The picture below illustrates how large our data set is by showing all the subdivisions within the Illinois Township selected (FIPS-33775).
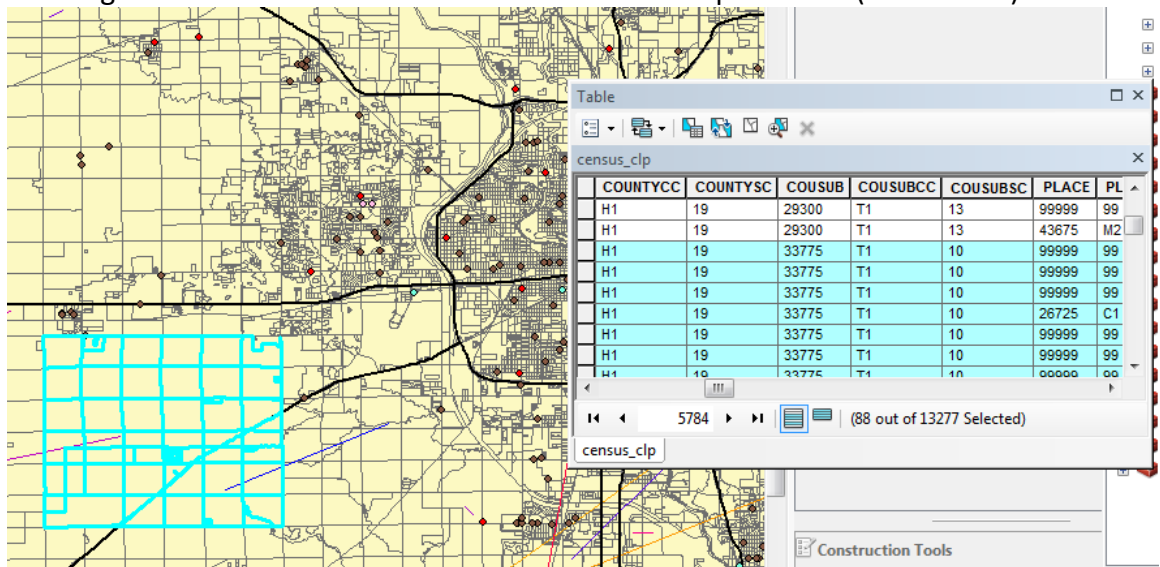

Figure 7. Highlighted subdivisions within the Illinois Township, Sedgwick County.

b. Open the attributes table for the population density shapefile and find which attribute contains the FIPS value. Here it is 'CouSub.'
c. Open up ArcToolbox and within the Data Management Tools, open the Generalization folder and use the dissolve tool. The population density shapefile will be the 'Input Feature.' Then select an appropriate name and folder for the new output. In the 'Dissolve Field,' select 'CouSub' so that we group the subdivisions by their respective townships. And make sure that the 'Unsplit lines' option is checked since we want the small subdivisions to appear merged. Click 'OK.'
d. Now all the subdivisions should be grouped by township in a new shape file; however, that new shapefile only has the values that were dissolved (the FIPS values). So now we need to join the data from the previous shapefile's attribute table. But before we can do that, we have to summarize the data, since the data we want (population) is broken up into subdivisions.
   i. To summarize our data by the township divisions, right click on the 'CouSub' attribute in the population density shapefile table, and click 'Summarize.'
   ii. Select the field to summarize, 'CouSub,' and then choose the values in the table that we want to be grouped by the township groups. We want to at least include the population values in the new table. We can sum the data, take a minimum, maximum, average, or even standard deviation of the population data. We will simply select the sum. Then specify the output table folder and name. Be sure to save the new file in 'DBF' format. Then click 'Ok.'
   iii. When ArcMap asks whether or not to add the new table to the database, click yes.
   iv. Now we have our table with the population values organized by township. Now we can join the tables. Right click on the township shapefile then click 'Join' in 'Joins and Relate.' Make sure the 'Join attributes from a table' is selected and then choose the field that the layer will be joined on: 'CouSub.' Then choose the table we just made as the table to join to that layer. Then click 'validate join' to see if the join will work. It should be fine, otherwise you'll have to trouble shoot. Then click 'Ok.' Now we should have the attributes that we summarized in the new table joined to the attribute table of the new township shapefile.
7) Now that we've down-sized our shapefile for the population density and organized the population data into townships, we can symbolize the shapefile by population.
   a. In the 'symbology' tab in the 'properties' window for the township shapefile, select 'quantities' and in the value field select 'Sum_Pop2010,'

which has the population values for each township within Sedgwick County.

    i.   Next click the 'classify' button. Then for 'classification method' choose the type of category break that makes the most sense for the data. Here we chose 'Geometrical Interval' for the 'classification method' and we chose 30 intervals to break up the population data.

   ii.   Then select the type of 'color ramp' to use for displaying the data. And then press 'Ok.' Below is an example of what the map should look like.
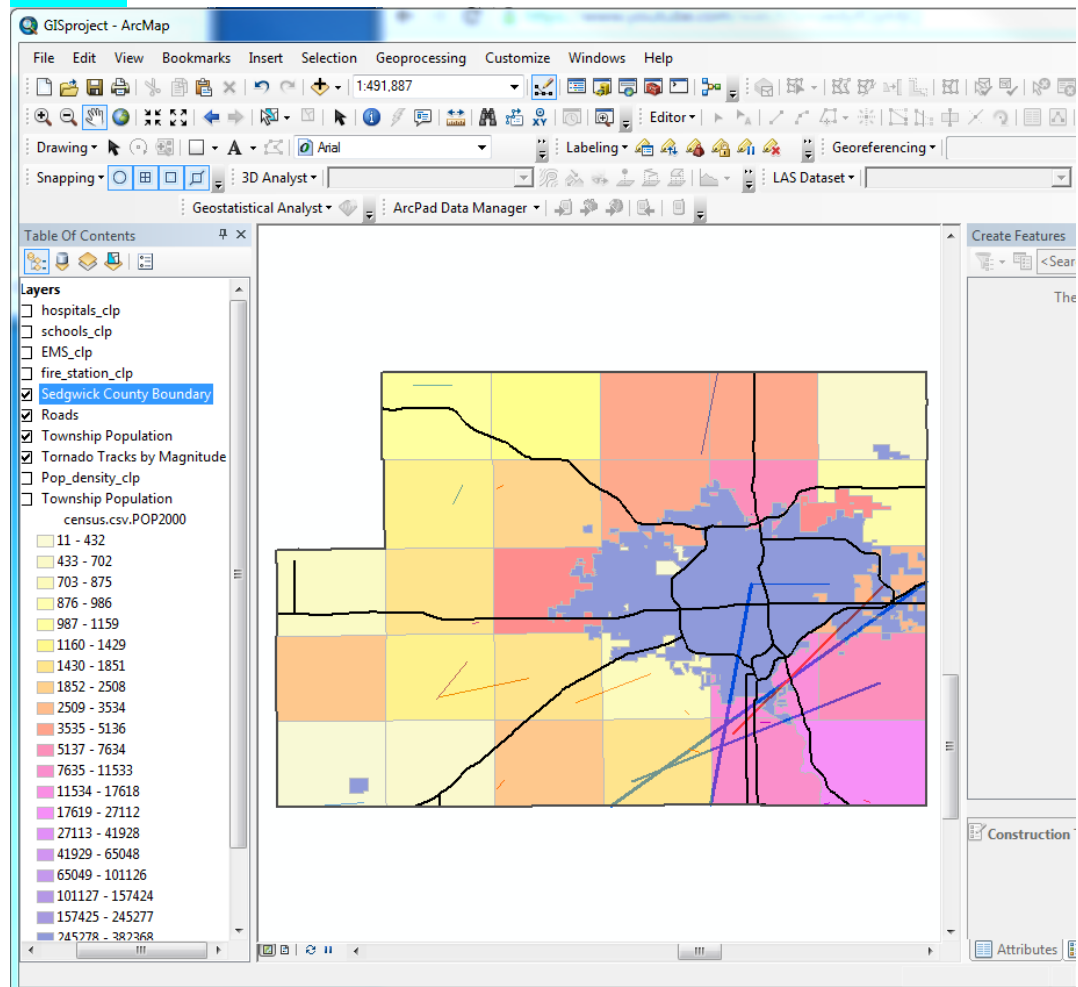
8) We've created a map successfully showing the 2010 census data versus the locations of tornado tracks and their magnitudes. But In order to see the change in population through time compared to where the tornados of certain magnitudes have struck, we want to create two more maps with the 2000 and 1990 Census population data. The 2000 and 1990 census data is not in shapefile format, but rather in chart format. We will join this excel file to the already in-place township shapefile, and then symbolize the map according to the new population values.

a. Input the data from the 2000 census and 1990 census in an excel spreadsheet along with a common attribute from the table.
    i. Save the excel spreadsheet as a csv file.
    ii. Import the table into ArcMap and right click on joins and relate. Then join the newly created table using the same steps as listed above. You may have to remove the previous join from that layer.
b. Next we want to use the new population data to symbolize the townships.
    i. We want to have the same interval breaks as the previous graph, so we're going to import the previous graph's interval breaks (we know that the highest population value is in the 2010 data, so there's no need to worry about the intervals not being high enough).
    ii. Click 'import' in the quantities section of the symbology tab and make sure that 'import symbology definition from another layer in the map' is selected.
    iii. Then click on the layer that contains the 2010 symbology for the 'layer'. Click 'Ok.'
    iv. Do the same procedures to create a 1990 population symbolized map.
9) Now analyze the graphs and draw conclusions from them.

RESULTS & CONCLUSIONS

The maps on the following pages are the maps created from the above procedure. Based on the maps created, there appears to only be one area that decreased after both 10 year census periods, and that is the Minneha Township. There also appears to be a category 5 (the highest wind speed category) tornado track listed for the year 1991. The Minneha label is bolded and the tornado track is highlighted in the year 2000 Sedgwick County Population vs Tornado Tracks map on page the last page. The population can been seen to decrease in the Minneha township by shifting from a reddish-color to an orange-ish color when comparing the maps from 1990 and 2000. If the population had increased, it would have turned more of a pink hue.
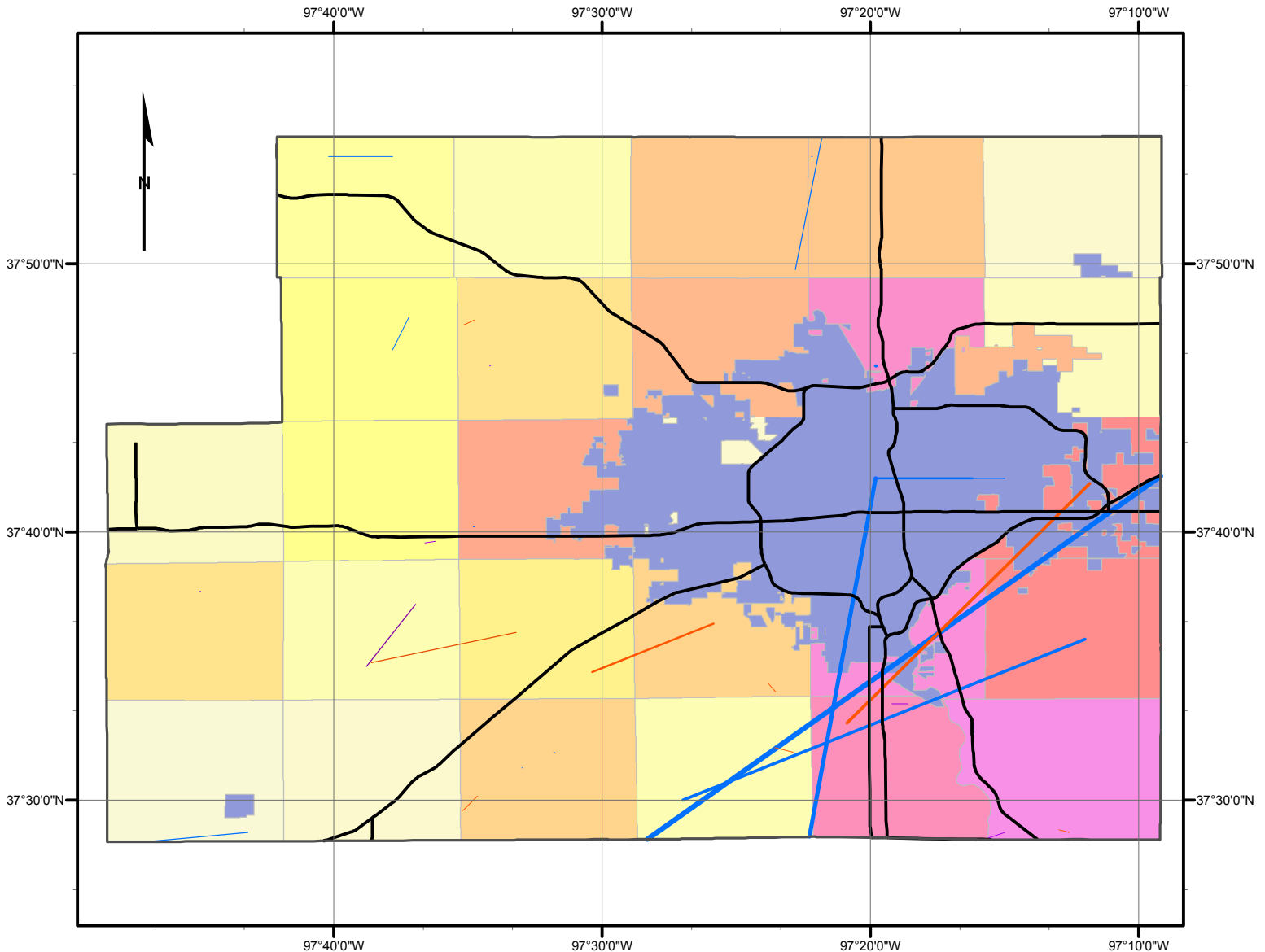
When we look at the census data for each year's population in the attribute table, we see that the population of the Minneha Township decreased from 6,566 in 1990 to 5,084 in 2000 which is almost a 23% decrease in 10 years. Upon further inspection of the attribute tables, a few other townships decreased in population, but there are no tornado tracks passing through those counties. In the other counties lesser category tornados passed through more densely populated areas, but those areas only seemed to increase in population. This can be interpreted in different ways. Either the population shift has to do with other circumstances besides tornado values, or only very high category tornados will affect the population.

If we had a more detailed way to sub-categorize the census population data by location, we might be able to conclude more strongly one way or the other. Also if we had population data with closer spaced intervals than 10 years we would have been

able to see when the shift in population occurred. With a better constraint on the timing of the population shift, we could have better concluded whether or not the timing of the tornado and its magnitude caused that population shift or not.

But based on the data we have, the conclusion one might draw is that only a very high magnitude tornado will have an effect on population shift.

Sedgwick County 1990 Population vs Tornado Tracks

37°50'0"N
37°40'0"N
37°30'0"N

97°40'0"W   97°30'0"W   97°20'0"W   97°10'0"W

N

NAD 1983

USA Contiguous Lambert Conformal Conic

0   4   8   16 Miles

Explanation:

☐ Sedgwick County Boundary

— Roads

Township Population

	11 - 306
	307 - 528
	529 - 693
	694 - 818
	819 - 911
	912 - 1035
	1036 - 1200
	1201 - 1422

	1423 - 1717
	1718 - 2112
	2113 - 2638
	2639 - 3342
	3343 - 4281
	4282 - 5535
	5536 - 7209
	7210 - 9445
	9446 - 12430
	12431 - 16416
	16417 - 21738

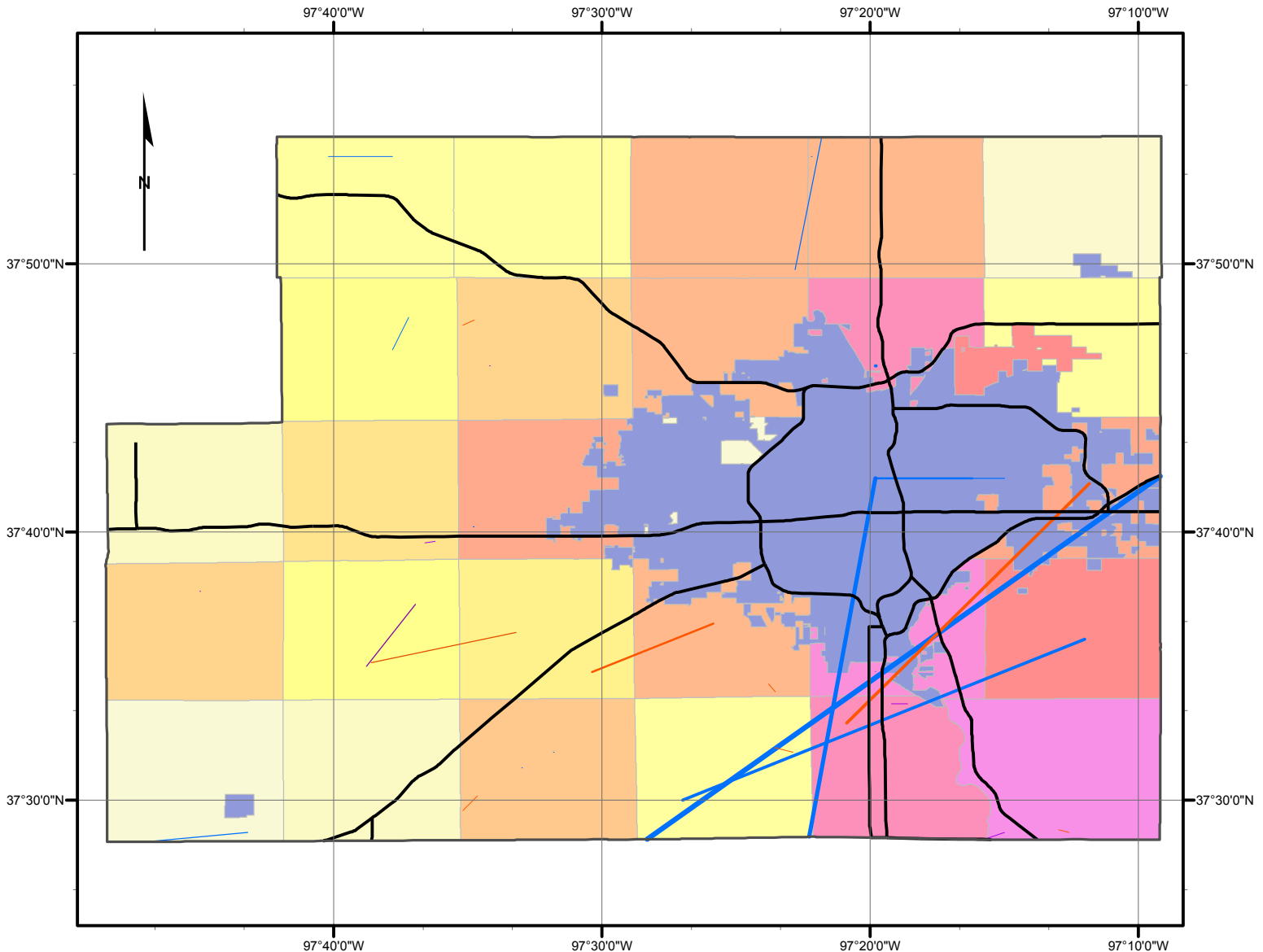|	
	21739 - 28844
	28845 - 38333
	38334 - 51002
	51003 - 67918
	67919 - 90506
	90507 - 120666
	120667 - 160936
	160937 - 214707
	214708 - 286503
	286504 - 382368

Tornado Tracks by Magnitude

— 0
— 1
— 2
— 3
— 4
— 5

Tornado Tracks By Year

— 1990-1999
— 2000-2009
— 2010-Present

Sedgwick County 2000 Population vs Tornado Tracks

NAD 1983

USA Contiguous Lambert Conformal Conic

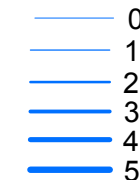0   4   8   16 Miles

Explanation:

Sedgwick County Boundary

Roads

Township Population

census.csv.POP2000

11 - 306	1201 - 1422	16417 - 21738
307 - 528	1423 - 1717	21739 - 28844
529 - 693	1718 - 2112	28845 - 38333
694 - 818	2113 - 2638	38334 - 51002
819 - 911	2639 - 3342	51003 - 67918
912 - 1035	3343 - 4281	67919 - 90506
1036 - 1200	4282 - 5535	90507 - 120666
	5536 - 7209	120667 - 160936
	7210 - 9445	160937 - 214707
	9446 - 12430	214708 - 286503
	12431 - 16416	286504 - 382368

Tornado Tracks by Magnitude

0
1
2
3
4
5

Tornado Tracks By Year

1990-1999
2000-2009
2010-Present

Sedgwick County 2010 Population vs Tornado Tracks

NAD 1983

USA Contiguous Lambert Conformal Conic

0 4 8 16 Miles

Explanation:

- Sedgwick County Boundary
- Roads

Township Population

- 11 - 306
- 307 - 528
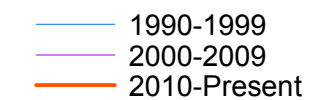- 529 - 693
- 694 - 818
- 819 - 911
- 912 - 1035
- 1036 - 1200
- 1201 - 1422
- 1423 - 1717
- 1718 - 2112
- 2113 - 2638
- 2639 - 3342
- 3343 - 4281
- 4282 - 5535
- 5536 - 7209
- 7210 - 9445
- 9446 - 12430
- 12431 - 16416
- 16417 - 21738
- 21739 - 28844
- 28845 - 38333
- 38334 - 51002
- 51003 - 67918
- 67919 - 90506
- 90507 - 120666
- 120667 - 160936
- 160937 - 214707
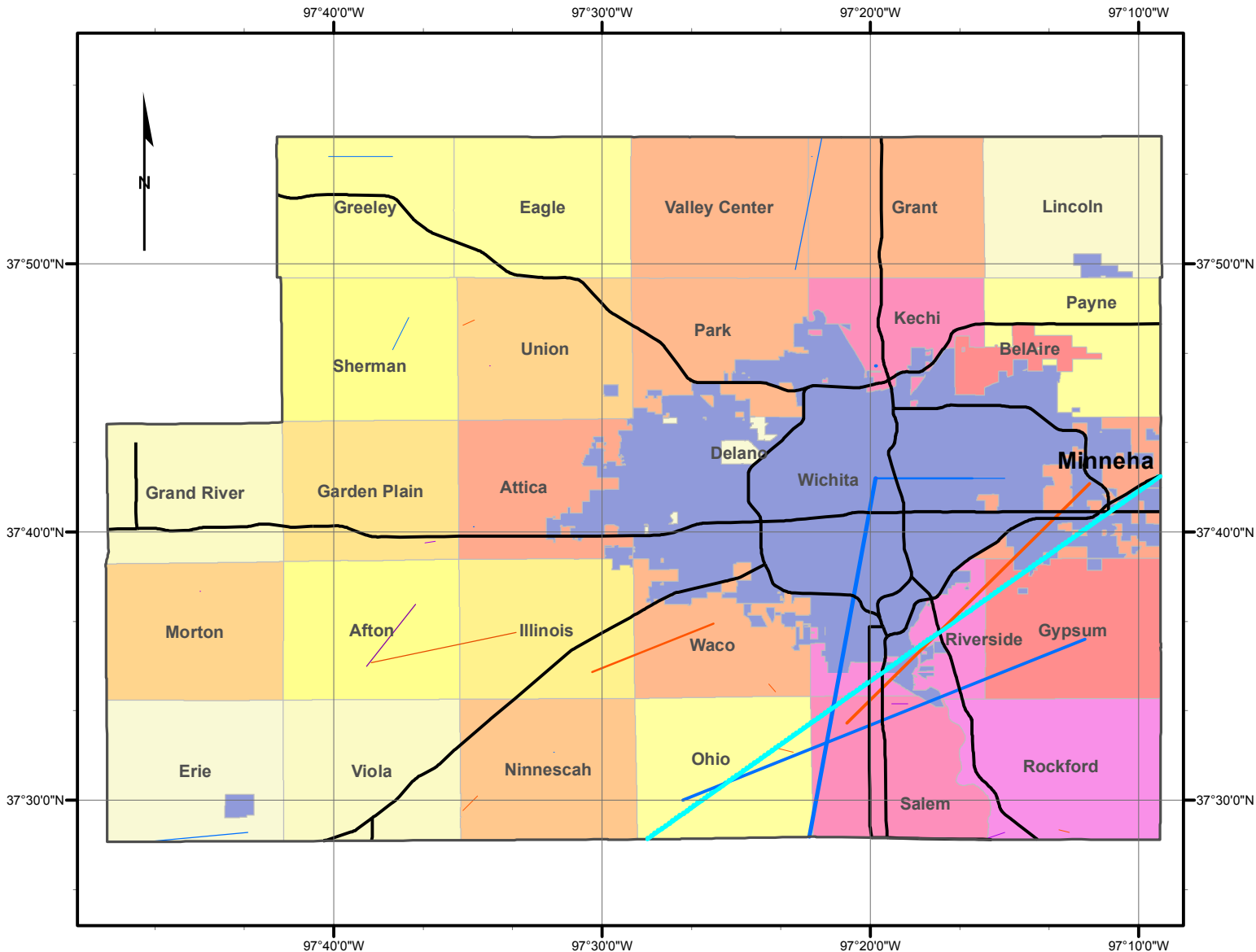- 214708 - 286503
- 286504 - 382368

Tornado Tracks by Magnitude
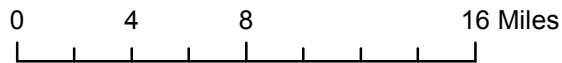
- 0
- 1
- 2
- 3
- 4
- 5

Tornado Tracks By Year

- 1990-1999
- 2000-2009
- 2010-Present

Sedgwick County 2000 Population vs Tornado Tracks

NAD 1983

USA Contiguous Lambert Conformal Conic

0   4   8   16 Miles

Explanation:

☐ Sedgwick County Boundary

—— Roads

Township Population

11 - 306	1423 - 1717	21739 - 28844
307 - 528	1718 - 2112	28845 - 38333
529 - 693	2113 - 2638	38334 - 51002
694 - 818	2639 - 3342	51003 - 67918
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1201 - 1422	7210 - 9445	160937 - 214707
	9446 - 12430	214708 - 286503
	12431 - 16416	286504 - 382368
	16417 - 21738	

Tornado Tracks by Magnitude

— 0
— 1
— 2
— 3
— 4
— 5

Tornado Tracks By Year

— 1990-1999
— 2000-2009
— 2010-Present